RAILROAD GAZETTE

THE TEHUANTEPEC ROUTE.

In another column Mr. E. L. Corthell, whose work on the Isthmus is well known, writes of the practical fulfillment of the project for a traffic route across the Isthmus of Tehuantepec, which for nearly four centuries has been the dream of those desiring access from the Atlantic Ocean to the Pacific and from the Pacific to the Atlantic short of Panama or the Straits of Magellan. Like all the trans-Isthmian projects—in number legion—this present Tehuantepec railroad, now so nearly completed, has been beset with many difficulties. The Vera Cruz & Pacific road, which occasioned a Baltimore banking institution so much trouble last fall, connects with this same Tehuantepec railroad, but was born too soon to gain thereby as an independent project, and now becomes part of the government through route from the north. As Mr. Corthell says in his paper, it is not to be expected that the Vera Cruz & Pacific will share very heavily in the trans-Isthmian traffic, because of the greater length of the Vera Cruz route, as compared with the straight route across from Salina Cruz to Coatzacoalcos; but, viewed purely as a Mexican and not as an interoceanic road, it would seem likely that it might pick up its share of a very pretty traffic to and from the City of Mexico. The suggestion which Mr. Corthell throws in, that this government majority ownership of the merger route from the United States border to Salina Cruz forms a long link in the proposed intercontinental system from New York to Buenos Aires does not strike us as important, for reasons which need not be entered into at this time except to point out in the briefest possible way that such a railroad, if ever the unsteady governments involved could get together and build it, would have to compete for through traffic with a deep-water route of about the same length. But it seems reasonable to expect that this new railroad unification in Mexico in connection with the trans-Isthmian route may develop a very important traffic indeed for points not quite so far distant as Buenos Aires.

As Mr. Corthell points out, the Tehuantepec project has not been confined in the minds of its advocates to an ordinary freight and passenger railroad. The canal idea has been much investigated and much urged. Mr. Corthell makes reference to the explorations and surveys made under the directions of the United States Navy Department by Captain R. W. Shufeldt, and published in 1872. Captain Shufeldt was impressed at that time by the fact that the Gulf of Mexico could be held against any foreign power and he pointed out that the channels between Cuba and Florida and Cuba and Yucatan on the south, being in the aggregate not more than 200 miles wide, could always be effectively closed by the navy, holding Key West and Tortugas as the base of operations. The chief engineer of that expedition, the late Mr. E. A. Fuertes, well remembered by readers of the *Railroad Gazette*, rejected the previously advocated canal plan of Señor Moro for feeding the summit level of a ship canal by means of the junction of the rivers Chicapa and Ostuta, as being impracticable, not only because a joint delivery of these two streams would have been insufficient, but because it would have been quite impracticable to effect the junction. Mr. Fuertes recommended the River Corte, or upper Coatzacoalcos, as a feeder, and proposed a canal 144 miles long with 140 locks. This canal was to be 22 ft. deep, 60 ft. wide at the bottom and 162 ft. wide at the top, but it would have required a 27-mile aqueduct feeder, which would have had to run under mountains, with three miles of aggregate tunneling and some heavy cutting. The true mean elevation of Tarifa, the lowest and most available pass in the mountains traversing the Isthmus from east to west, was 72 ft. higher than the river counted on to furnish the water, as measured in the dry season. The proposed dam to raise the elevation 72 ft. was only a small part of the difficulties which this route involved, and, after all had been done, the Fuertes survey only provided for a 22-ft. minimum depth in the canal, while the depth of the Suez Canal, which, in spite of its enlargement is too small to admit of the practicable passage of our large present day steamers, is 31.2 ft.

The interoceanic route described in Mr. Corthell's present paper involves trans-shipment of goods from steamer to wharf and from wharf to steamer, a serious obstacle. And yet, the writer points out how quickly this may be done with improved appliances, and he balances off the time of a Panama passage with the time of a Tehuantepec trans-shipment much to the advantage of the Tehuantepec route. We are disposed to consider this trans-shipment as a difficulty considerably more serious than it appears to Mr. Corthell, but it should in any event be possible and feasible to transfer passengers and valuable goods in this manner, so that the approaching completion of the present Tehuantepec railroad is an event of real and of great importance.

THE ECONOMIC LIMITS OF LEGISLATIVE AUTHORITY.

The most potent legislative body cannot exercise effectively every power with which it may nominally be endowed. The monarch who attempted to order the tides was no more impotent to force them to obey his will than the Parliament which sought by statute to prevent the workmen of England from obtaining the enhanced wages that were the natural consequence of the scarcity of labor caused by the ravages of the black death. Beside the inexorable law of supply and demand the fiat of the most august legislative assembly is a vain and useless expenditure of effort. But that which cannot be accomplished by direct means can sometimes be brought about by indirect measures. If the markets of the United States were open to foreign producers, no statute could enforce a price of $30 per ton for steel rails at a time when similar rails sold in Canada for $20 per ton, or in England for $15 per ton, but by fixing a tax on imported rails of $20 per ton the high domestic price might, we do not say it would, be maintained. No statute could effectively fix the wages of common labor at $3 per day, but arbitrary restriction of the labor market might, temporarily at least, make it impossible to conduct enterprises which could not afford to pay that rate.

We are moved to these reflections upon the plain teaching of the economic history of the world by a sentence contained in an article contributed to the *North American Review* for June by Hon. Charles A. Prouty, a member of the Interstate Commerce Commission. Mr. Prouty declares that "the only way to regulate railroad rates is to regulate them," by which he evidently means that the Commission of which he is a conspicuous member ought to have rate-making authority. Such a declaration clearly arrays its author with those who, in spite of the lessons of experience, believe that legislation is all-powerful and who would fall back upon the law-making power for relief from every ill of industrial life. It is all the more surprising coming from a member of the body which for seventeen years has struggled with varying degrees of ineffectiveness, to secure the observance of rates named by the carriers themselves, for it would seem that the plainest teaching of that experience ought to be the fact that railroad transportation will, in the end, sell for the price (or rate) which those who desire it and can afford to pay for it are willing to pay. How can it be imagined that rates made by statute of Congress or by a Commission entrusted with a part of the Congressional authority over interstate commerce can be enforced if all of the agencies of the Commission and of the Federal Department of Justice have for nearly two decades proved powerless to compel the railroads to sell transportation at the rates named in schedules promulgated by their own officers? The Interstate Commerce law requires that every participant in interstate railroad transportation shall publish schedules showing all its charges and shall file copies of every schedule and every charge in such schedules with the Commission. Deviations from the rates named in these schedules are misdemeanors always punishable by fine, and during most of the seventeen years they have also been punishable by imprisonment. Yet every annual report issued by the Commission has its story of wholesale departures from the legal rates. One after another, in annual succession, the Commission has devised and recommended new safeguards against such violations of law. Some of the amendments suggested have been adopted and at least one of them has been repealed as well in accordance with a later suggestion from the Commission. But rate-cutting has not stopped, although during the recent period of heavy traffic it was greatly reduced. The law in regard to evidence was amended so as to remove the opportunity to avoid testifying in regard to rate-cutting on the ground that it might be self-incriminating, and the courts have been invoked, as in the Brimson and Brown cases, but there has been no complete disappearance of the practice. Even injunctions and the Elkins law have been avoided by means of allowing excessive divisions to industrial railroads and special allowances to the owners of private cars. What can all this mean, unless it is that rates which lack the eco-

nomic sanction, that is, those which fail accurately to express the actual relation between the supply of railroad transportation and the demand for it are unstable and are sure to be discarded in favor of those which meet the requirements of the situation? Yet Mr. Prouty thinks that the Commission can prescribe rates for the two hundred thousand miles of railroad and the billions of dollars of annual traffic of the United States. The railroads employ hundreds of traffic experts, men whose lives have been devoted to the study of industrial needs and often those of restricted sections or particular classes of traffic. These experts have formulated schedules of rates, and the whole power of Congress, supplemented by the wishes and commands of railroad owners, has failed to secure the observance of the rates named in these schedules. Is it reasonable to assert that where these experts have failed invariably to discover the stable rate, a body of five lawyers, however distinguished and able, can succeed? Yet that is precisely the conclusion to which Mr. Prouty's article leads. He overlooks or wilfully rejects the proposal to secure reasonable stability by removing the incentive to rate-cutting, that is, by permitting agreements to maintain rates and to divide tonnage or earnings, and chooses the direct, arbitrary and universally ineffective method. He proposes legislation on an exact par with that against which Adam Smith directed the strongest portion of "The Wealth of Nations," the successive failures of which are so skilfully recorded by Thorold Rogers.

RAILROAD SHOP TOOLS.

The design of machine tools is being revolutionized by the perfection of high-speed steels. Cutting feeds and speeds have been greatly increased, with the result that most tools designed even five years ago have developed serious defects and weaknesses. Machine tool builders, at first, attempted to meet the demand for more powerful machines, by merely increasing the weight of the parts without altering the design, but this expedient has in most cases failed. The result is that the modern machine tool has been entirely redesigned with due regard for the magnitude and character of the stresses which it will be called upon to withstand. For example: in the case of many heavy driving wheel lathes the face plate is driven directly by a gear meshing with teeth on the face plate instead of being driven through the spindle. This design does away with the torsional strains in the spindle which produce chattering and which increase the liability of failure. Boring mills, lathes, planers, etc., have also undergone many radical changes in design. In giving to our readers a series of articles describing modern machine tools for railroad shops, we hope to perform a useful service. Only such tools as represent the best modern practice are being described, and the selections are by experts on the subject. The art is, of course, in a state of transition, but when the entire series has been completed it will embrace the important tools used in the several departments of railroad shops. The subject is one that is of great importance to those interested in the efficiency of railroad shops, but the machine tool is not the only element in shop organization that requires attention. Good organization is an important factor, and it is about as unreasonable to equip a shop with powerful high speed rapid reduction lathes, if they are not worked to their capacity, as it is to buy a powerful high speed locomotive if the condition of the permanent way is such that speeds higher than 30 miles an hour are impossible. Good organization and good tools are both desirable and necessary if the highest possible efficiency is to be obtained.

A full extract is given elsewhere in this issue of Mr. von Schrenk's Bulletin on the use of screw spikes and dowels. From the standpoint of common American conditions, the obvious criticism to be made is that a tie must be creosoted or otherwise preserved before the economy to be effected can be expected to balance the additional first cost. Where untreated ties are used, the limit of service is generally occasioned by decay elsewhere than around the spike hole. The decay in white oak ties, starting in the heart of the wood, spreads out radially, eventually loosening the hold of the spike, and the use of dowels might be expected to increase their service somewhat. But the scarcity of white oak leads to the restriction of its use to points of special strain, such as on curves, and it is not thought desirable to prolong the use of a tie in such a position after decay has spread to any extent. Yellow pine ties, in much more common service, decay from the bottom up, and the spike holes, after they have been plugged and the spikes redriven through the plug, commonly hold well until it becomes necessary to replace the tie on account of trouble elsewhere. Therefore wherever untreated ties are used, their eight or nine years of service would probably not be much extended or bettered by the use either of screw spikes or of dowels. With treated ties, the conditions are quite different. The difficulty in all preservation processes is, at reasonable cost, to make the creosote or other preservative penetrate deeply into the wood. Generally speaking, the spike hole is a channel through the protective armament to that part of the tie which has received the least treatment, and moisture finds its way in, causing decay around the spike. The dowel, well saturated with creosote throughout its entire length, effectively checks this, and is itself protected by its absence of fibre ends, since the grain of dowel runs parallel to the direction of the spike. Where treated ties are used, it seems well worth while to imitate foreign practice in this method of protecting the exposed part from decay. Although this comment refers particularly to the use of dowels, much the same argument applies to screw spikes. So long as the edges of the spike hole are firm around the driven spike, it does its work satisfactorily, and the additional cost of screw spikes and of their application seems hardly justifiable. Therefore, when ties are used that decay from the bottom up, before the tie is rejected on account of deterioration of its spike-holding qualities, the chief value of the screw spike lies in the fact that it may lessen the work of caring for a stretch of track which has been heaved by frost. When it becomes necessary to place shims under a rail, a turn or so with the key would raise the head of the spike without tending to break its hold, and it could afterwards be tightened again in a similar manner. But the special value of the screw spike, like that of the dowel, would seem to be its use in preserved timber, where the wood around the spike hole is the weakest part.

The rear collision at Midvale, N. J., last Sunday, killing 16 passengers, makes two passenger train horrors of the first magnitude in this month, and so lengthens the list for the last 12 months as to discourage the notion that the law of averages would soon ease up. The railroad traffic of this country is now so enormous and increases so steadily that unless our methods are improved our fatalities are sure to increase. The officers of the Erie, at this writing, seem not to have decided whether to believe the signalman or the engineman as to which made the fatal error in this case. That such cases sometimes remain forever undecided, is familiar to all who read the English blue books on accidents, and to railroad superintendents from their own experience. Reflections on this case must therefore be postponed until the inquiry is finished. In the meantime it is well to bear in mind that the interesting question whether automatic block signals are safer than the simple "telegraph block system" is by no means settled by a single case of this kind, or even by repeated cases. The track circuit, now a vital feature of all our automatic signals, has undoubtedly many times performed its function, preventing collisions, when a human guardian would have failed. Whether the failures of the track circuit, plus the errors which enginemen have made with automatics, but would not have made if watched by signalmen, have equaled or exceeded the errors of signalmen under a similar volume of traffic no one knows. But we do know that manual signaling has made a fine record in England, and that our manual signaling cannot fairly be condemned on principle unless it can be shown to be inferior to the practice in England. And, if inferior, what is the reason? The Erie has consistently stuck to the manual system while all of its important neighbors have adopted automatics. The first question, therefore, in the present case, is not one of systems but, rather, whether the system used was managed in the best possible way.

The Detroit Southern Receivership.

The appointment of a receiver for the Detroit Southern, announced in these columns last week, could scarcely have come as a surprise to those who have followed the history of the road. The Detroit Southern was chartered in May, 1901, as successor to the Ohio Southern and the Detroit & Lima Northern railroads, forming a line from a point not far southwest of Detroit, running through Lima and Springfield, Ohio, to Wellston. A little property known as the Iron Railway, affording an entrance into Ironton, was also bought, but financial difficulties have prevented this link being coupled on to the others. Lacking a Detroit terminal on the north and a connection through to Ironton on the south, the Detroit Southern was compelled to pay heavily for trackage, and was in the unfortunate position of a line with neither head nor tail, in a country served by many com-

peting railroads which did not labor under this disadvantage. Of the two links forming the main portion of the route as reorganized in 1901, the Detroit & Lima Northern, opened from Lima to Adrian, Mich., in 1896, was in chronic difficulties, and went into the hands of a receiver on a contractor's suit in 1898. The Ohio Southern, organized in 1881 as successor to the Springfield Southern, was also an unfortunate property, recording a deficit in 1895, 1896, 1897 and in 1898, in which year it was sold under foreclosure of the first mortgage. The consolidation of these two defaulting properties, with insufficient funds under the reorganization to put the new line in order and give it an entrance into Detroit and a through line to Ironton, did not start auspiciously, and the first annual report issued by the Detroit Southern for the year ending June 30, 1902, complained of things which were certainly to have been looked for under the circumstances; shortage of motive power and other equipment, and bad condition of such equipment as the company owned, for the reason that neither of the component companies had been able to spend the requisite amount on maintenance or renewals. The per diem rule also fell upon the company most inopportunely, with the result that all its bad order equipment was brought back and left on its doorstep, and, besides these discouragements, the first year of the reorganization saw a dry season, when the streams on which the company was compelled to depend for water supply for its engines were very low, and the quality of the water so extremely bad as to be ruinous to boilers. Another difficulty apparently not anticipated, was that during the receivership of the Detroit & Lima Northern the scale of wages paid the employees was only 65 per cent. of that paid on the Ohio Southern and by other roads in the same territory, so, after the consolidation, this unfortunate discrepancy had to be done away with at considerable cost to the new company.

The 1902 year passed with a deficit from the year's operations of $73,205, but in 1903 hope was renewed by quite an increase in the gross earnings, so that the 1902 deficit as carried forward was reduced somewhat by a small surplus from current operations, and on the first of November, 1903, gross earnings were $100,000 ahead of the year previous at the same time. But during that month the road's troubles began again. The locomotives were again seriously hurt by bad water, causing a loss of over $100,000 in net earnings, and by the time these conditions had been overcome the severe winter weather set in. Besides this, the bituminous coal business of the Jackson district, normally furnishing over 50 per cent. of the total tonnage, was extremely unsatisfactory. In consequence of these things, taken together with general depression, the company was unable to meet the interest on the 50-year, first-mortgage, 4 per cent. bonds, due June 1, and Samuel Hunt, President of the road, has been appointed receiver.

This receivership, involving some 500 miles of line, is the most important of any which has occurred for several years. The only other noteworthy receiverships created this year have been that of the Tennessee Central, 308 miles, which was only in existence a short time before a satisfactory arrangement was made for resuming operation on the former basis; the Atlantic & North Carolina, 95 miles, which is now being operated by the State of North Carolina, its principal owner, pending court action in the fall; the Quebec Southern, 139 miles, and the Brunswick & Birmingham, 109 miles. The other four roads for which receivers have been appointed since the first of January are small and unimportant properties, aggregating only 103 miles. In view of the quite prevalent depression of the last few months, this record is an extremely good one, comparing with 13,730 miles of line worked by the 58 roads which were sold under foreclosure in 1896, and the 12,831 miles worked by 52 roads sold under foreclosure in 1895. It shows, what was already known and commented on, that the roads of the country in general are in far better shape to withstand a dull period than they have been at previous times of depression. The Detroit Southern receivership comes less as the result of an operating failure than as an unsuccessful attempt to redeem a previous failure.

The advance sheets of the report of the Interstate Commerce Commission for the year ending June 30, 1903, give the total single-track railroad mileage in the United States on that date as 207,977 miles, an increase of 5,505 miles over the report for the year ending June 30, 1902. This is the largest increase reported by the Interstate Commerce Commission since 1890. The operated mileage for the year was 205,313 miles, which includes 5,902 miles of line on which trackage rights were exercised. The total length of railroad mileage, including second, third and fourth track and sidings, was 283,822 miles. This total shows an increase of 9,626 miles in the aggregate length of all tracks operated. The number of railroad corporations included in the report was 2,078. Of this number 1,036 maintained operating accounts, 805 were classed as independent operating roads and 231 as subsidiary roads. The number of locomotives in service on June 30, 1903, was 43,871, an increase of 2,646. These locomotives were classified as follows: Passenger, 10,507; freight, 25,444, and switching, 7,058. The total number of cars in service was 1,753,389, an increase of 113,204 over 1902. This rolling stock was classified as follows: Passenger, 38,140 cars; freight, 1,653,782 cars, and the remainder, 61,467 cars. These latter were employed directly by the railroads in their own service. Of the total number of locomotives and cars in the service of the railroads (which was 1,797,260), 1,462,259 were equipped with train brakes and 1,770,558 were equipped with automatic couplers. The number of employees on the payrolls of the railroads in the United States on June 30, 1903, was 1,312,537, or 639 per 100 miles of line. These figures, when compared with the corresponding ones for 1902, show an increase of 123,222 in the number of employees, or 45 per 100 miles of line. The par value of the amount of railroad capital outstanding on June 30, 1903, was $12,599,990,258, or a capitalization of $63,186 per mile. Of this amount, $6,155,559,032 was stock and the remaining portion of $6,444,431,226 consisted of mortgage bonds, income bonds, car trust certificates and miscellaneous obligations. Of the total capital stock outstanding, 44 per cent. paid no dividends. For the year ending June 30, however, the amount of dividends paid by the railroads in the United States was $96,728,176. The number of passengers carried during the year was 694,891,535, an increase of 45,013,030, as compared with the year ending June 30, 1902. The number of tons of freight carried was 1,304,394,323, which was an increase over the tonnage of the previous year of 104,078,536 tons. The ratio of operating expenses to earnings was 66.16 per cent., as compared with 64.66 per cent. in the previous year. Gross earnings for the year were $1,900,846,907, or an increase of $174,466,640 over 1902. Operating expenses were $1,257,538,852, or $141,290,105 more than in 1902. Net earnings amounted to $643,308,055, being an increase of $33,176,535 over 1902. The total number of casualties to persons on the railroads for the year ending June 30, 1903, was 86,393, of which 9,840 represented the number of persons killed and 76,553 the number injured. The statistics show that one passenger was killed for every 1,957,441 carried, and that one was injured for every 84,424 carried. In respect to the number of miles traveled, however, the figures show that 58,917,645 passenger miles were traveled for each passenger killed, and 2,541,096 passenger miles for each passenger injured.

Most of those who took part in the discussion of the advisability of using screw reverse mechanism for large modern locomotives, at the last Master Mechanics' convention did not believe that the screw mechanism was practicable. Quick reverse being a vital consideration, it was held that the screw reverse mechanism could not be made to meet the requirements. The two principal advantages of the screw mechanism are, first, the possibility of obtaining any rate of expansion, and, second, the ease with which the valve mechanism can be moved. The principal objection to its use is that the engine cannot be reversed quickly. Its use would probably cause confusion in case of emergency, because American enginemen have been trained to use the lever reverse mechanism. For switching service, screw mechanism would never be favorably considered. Furthermore, all freight locomotives have considerable switching to do on the road, and even passenger engines are frequently pressed into such service. Although power brakes enable quick stops to be made without using the reverse lever, certain kinds of flying switches, "spotting" the engines at coal and water stations and on turntables, etc., require work with the reverse lever. With a screw mechanism many of these operations would be difficult, while, at best, considerable loss of time would occur. The best solution of this problem, especially since valve mechanisms have become more and more unwieldy, would be some power device for moving the lever quickly and positively. A good many devices of this sort have been designed, but none have been generally used because of inherent defects, so that the hand operation of the reverse lever has remained the preferred method. The device on the Mallet compound built for the Baltimore & Ohio, and described in these columns May 27, 1904, is simple in design and positive and effective in action. An air, or steam, cylinder, placed tandem of an oil cylinder, is used, the oil serving to govern and retard the motion. This principle is not new, but the present application is such as to give very satisfactory results. A complete reversal from the front to the back corner of the quadrant can be made quickly and without exertion on the part of the engineman. The reverse lever is a good indicator to the engineman of the condition of the valves of the locomotive. By unlatching the lever he can tell if the valves are sticking.

TRADE CATALOGUES.

The Baldwin Locomotive Works has issued an illustrated pamphlet descriptive of their exhibit at the St. Louis Exposition. A brief history of the works is given, which includes such information as the number of men employed, the horse-power required to operate the works, the consumption of coal in tons per week, and the total area of floor space in acres, etc. An interesting account is also given of the first locomotive made

by the company. This locomotive was built in 1832 for the Philadelphia, Germantown and Norristown Railroad. The company up to the present time has built 24,000 locomotives. An illustration and description of the locomotive completing each 1,000 is given. The twenty-four-thousandth locomotive was built in March, 1904, for the Atchison, Topeka & Santa Fe. This is a four-cylinder balanced compound of the Atlantic type and is part of the exhibit at St. Louis. Following these descriptions are a number of illustrations and dimensions of typical locomotives. The remainder of the pamphlet is devoted to the Baldwin-Westinghouse electric locomotives and to electric motor trucks.

The Link Belt Engineering Co., Philadelphia, has just issued their 1904 edition of the Renold silent chain booklet. A detailed description and illustrations of the recently patented bushed type of chain is given. It is claimed that this type of chain is practically non-elongating. The book is illustrated with views which show some of the applications of the Renold chain which are in actual service throughout the United States. The last few pages are devoted to a number of questions which will help the customer in ordering this type of chain. The same company issues a booklet on "Retail Coal Pockets," in which is given some comparative costs of the pocket system and other methods of storing coal. The book is illustrated with photographs of plants which are in operation, and also contains a number of detailed line drawings in which the operation of these plants are clearly shown. In the back of the book is given a partial list of retail coal pockets equipped with the company's machinery.

The Chicago & North Western has published an attractive and useful pamphlet on "The Lakes and Summer Resorts of the Northwest." It is intended as a tourist's guide to the summer resorts and hunting and fishing grounds reached by the North Western. It contains a fine lot of half-tone views and three large detail maps. There is also, in the back, a list of hotels and boarding houses at all of the resorts and fishing and hunting grounds, giving rates, capacity, distance from station, etc. The printing and engraving and the general get-up of the volume are excellent.

The Philip Carey Manufacturing Co., Lockland, Cincinnati, Ohio, issues a catalogue descriptive of Carey's magnesia coverings. The book is illustrated throughout with views of buildings and power plants in which this company's covering is used. The first few pages are devoted to a brief but interesting description of magnesia and asbestos. The following pages set forth the economic and other advantages of its use.

Charles Engelhard, 41 Cortlandt street, N. Y., issues a booklet descriptive of the Le Chateliers pyrometer. This instrument is used for measuring temperatures in ovens, cupolas, boilers, etc. It will register temperatures from 0 to 2,920 degrees Fahrenheit. A detailed description and drawings are given. The book also contains tables of the melting and boiling points of various substances, and other useful data.

The Magnolia Metal Co., New York, has issued an illustrated handbook of useful information for those who use that metal. A number of tests of magnolia metal, as well as other anti-friction metals, are given. A few illustrations showing the proper method of applying this metal to the various types of bearings are also shown.

Ingersoll-Sergeant Drill Company (Pneumatic Tool Department) has published a pamphlet containing a full description and illustrations of the Haeseler "axial valve" hammers. Reference is made in the pamphlet to the scope of a recent decision of the Supreme Court bearing on the patented features of pneumatic hammer handles.

The Goldschmidt Thermit Company has issued an illustrated pamphlet which describes the application and use of Thermit in foundry practice. The compounds include Titan-Thermit for molten iron, Lunker-Thermit for steel castings, and the Anti-Piping Thermit to prevent piping in steel ingots.

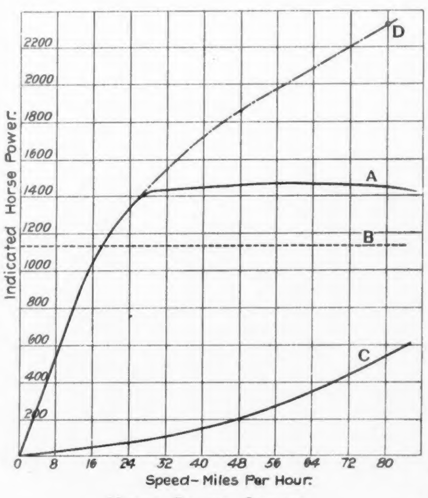
CONTRIBUTIONS

Heating Surface and Boiler Power.

Philadelphia, June 28, 1904.

TO THE EDITOR OF THE RAILROAD GAZETTE:

The article by Mr. L. B. Jones, on the above subject, published in the issue for June 24, describes a run which is remarkable chiefly because it was made in regular service and represents an almost everyday



Horse Power Curves.

performance. The present writer was on the train, and independent timings taken between stations check up very accurately with the speed curve presented by Mr. Jones.

In considering the performance of this locomotive, it is interesting to compare it with what would ordinarily be expected of an engine of its nominal capacity. In a catalogue issued by the Schenectady Locomotive Works in 1901 are given factors showing the relation between piston speed and mean effective pressure, and from these have been figured the drawbar pull and horsepower and the total tractive effort and indicated horse-power speed of 80 miles per hour. Similar calculations have been made, using the formula of Prof. Goss, which was published in the *Railroad Gazette* of January 17, 1902. The results, together with the figures actually developed in the run under consideration, are given in the following table:

	Draw bar pull.	Draw bar horse-power.	Total tractive effort.	Indicated horse-power.
Schenectady factors...	3108	663	6807	1453
Prof. Goss's formula..	2819	602	4250	1133
Actually developed....	6160	1322	10830	2325

These figures are interesting chiefly because Prof. Goss's formula is based principally on the heating surface, while the factors given in the Schenectady catalogue refer to mean effective pressure only. To develop 2,325 horse-power at 80 miles per hr. this engine requires a mean effective pressure of about 80 lbs., while the Schenectady factor at that speed allows but 50 lbs. While 80 lbs. may be rather high, it is evident that the steam distribution of class E_2 is very fine. The engine is equipped with balanced slide valves driven by the Stephenson link motion. A special feature is the double link suspension, there being a hanger on each side; a device which has been used with good results on all heavy engines recently built for this road.

Prof. Goss' formula is based on the expression $T = 161 \dfrac{H}{S}$, where T is the total tractive effect, H the heating surface and S the speed in miles per hour. This equation may be transformed to read:

Indicated horse-power $= \dfrac{H}{2.33}$, and hence for class E2, I. H. P. $= \dfrac{2640}{2.33} = 1133$.

This formula is based on the assumption that 2.33 sq. ft. of heating surface are required per horse-power, and if we allow an average of 26 lbs. of water per horse-power the rate of evaporation will be $\dfrac{26}{2.33} = 11.16$ lbs. per square foot of heating surface per hour. These figures are doubtless correct for average practice, but in the present instance the rate of evaporation was very much greater.

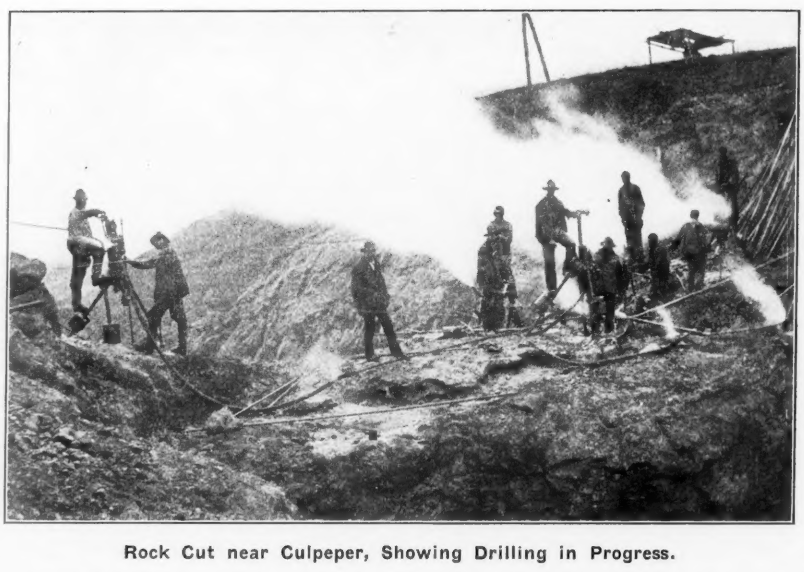
The accompanying diagram shows horse-power curves for the engine under consideration. Curve "A" was plotted from the Schenectady factors, curve "B" from Prof. Goss' formula, while curve "C," which was plotted from the same formula, developed to give the drawbar pull, shows the power required to run the engine and tender alone. The actual power developed (2,325) is plotted at point "D". It is interesting to note, as shown by the dot and dash line, that this point is on the natural continuation of the Schenectady curve before the sharp change in direction occurs at a speed of about 30 miles per hour. The writer has seen records of tests made with locomotives in which the horse-power varied directly as the speed, and it is not unfair to suppose that this engine is capable of producing a similar horse-power curve. In other words, what has been called the "critical speed," or the point where the horse-power begins to decrease with an increase in speed, is not met within the limits of ordinary running; and the boiler is capable of maintaining full pressure at the highest speed.

The development of the Atlantic type locomotive on the Pennsylvania, since the introduction of Class E, in 1899, has been most interesting, and the various classes have been characterized by boilers having ample grate area and provision for free circulation, with a moderate heating surface; also the use of balanced slide valves, plenty of weight on the drivers, and a careful attention to details. The latest example is Class E3a, which is similar to Class E2; the principal difference being the cylinders, which are 22 in. x 26 in., and the weight on drivers, which reaches the very high figure of 118,000 lbs. The heating surface and grate area remain the same as in the earlier engines. Class E_3a is working most of the express traffic on the Pittsburg and Philadelphia Divisions, where severe grades are encountered;

oolitic limestone and Lehigh Portland cement were used in the construction of the masonry, which was built upon solid rock foundation, 3 to 12 ft. below the surface. The abutments are each 8 ft. x 20 ft. on top, with parapet wall 7 ft. high, and wing walls at 45 deg. to fit a slope of 1½ to 1. Measuring from top of parapet wall to foundation, the abutments are respectively 57 ft. and 62 ft. high, and 19 ft. and 23 ft. thick at foundation. The piers are each 3 ft. 6 in. square, covered by coping 4 ft. square, and extend from 2 to 7 ft. above the surface of the ground. Two anchor rods, each 1½ in. in diameter, are placed in each pier and extend entirely through the pier into solid rock. These rods are split and wedged at the bottom and grouted with a 1 to 1 sand-cement mixture, and were all placed and rigidly grouted before placing any of the steel superstructure.

One of the illustrations shows the traveler, 105 ft. high, used in erecting the steel work. The girders are alternately 60 ft. and 30 ft. in length, 7 ft. center to center, and 6 ft. deep. The columns of the towers have a batter of 1 to 6, and rest on heavy cast-iron shoes. The trestle is designed to carry two 159¾-ton engines followed by a live load of 4,500 lbs. per lineal foot, and is made of medium open-hearth steel. The specifications used were those of the American Bridge Company. The trestle is built on a grade of 1½ per cent. and the alinement is tangent. The total weight of the steel and iron work, including castings, is 1,091,000 lbs.

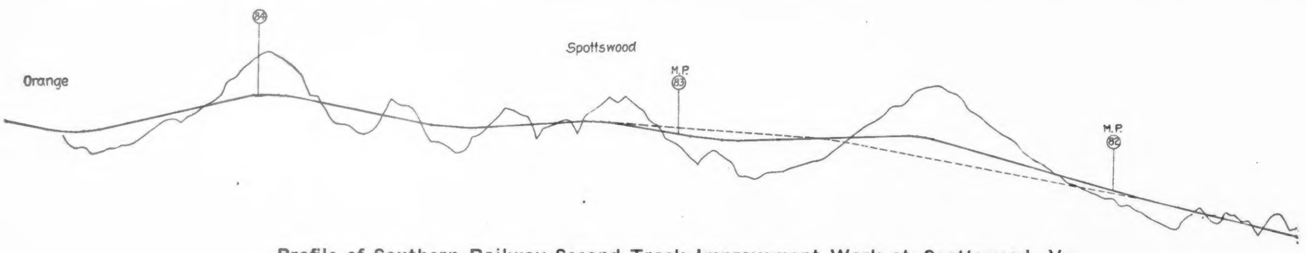
The steel trestle was designed by Mr. Andrews Allen, of the Wisconsin Bridge & Iron Company, which company built and erected the trestle. The design was checked by Mr. Ralph Modjeski, Consulting Engineer, Chicago, who also inspected the work as it was completed in the shops of the bridge company. The masonry was pronounced by those erecting the structure to be the most perfect, from an engineering standpoint, upon which they had ever placed a bridge. The surveys and general plans for the work were made by Mr. W. A. Wallace, Division Engineer of the Monon, assisted by the writer, who also acted as Assistant Engineer in charge of construction.



Rock Cut near Culpeper, Showing Drilling in Progress.

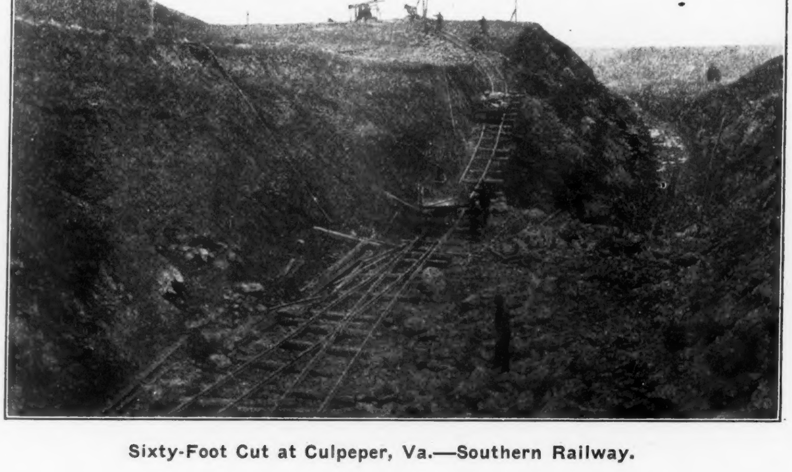
Second Track Work on the Southern Railway.

The purpose of the second track and revision work now being done by the Southern is to make that road the best freight and passenger route from Washington to the commercial centers of the South, by doing away with the heavier grades and high curves on the present line. The work, which was begun two years ago, consists not only of revision of the present line, but also in building of a second track between Alexandria, eight miles out of Washington, and Orange, 78 miles. This is only part of the final plan, however, as it is the intention of the railroad company to eventually extend the double track to Charlotte, N. C., 300 miles from Orange. This will enable the Southern Railway to successfully cope with the large increase in freight and passenger traffic to all points in the South. An example of how large this increase has been may be obtained from the last three reports of the company, which shows that in 1901 the freight tonnage was 14,121,181 tons, in 1902 16,811,538 tons and in 1903 19,197,484 tons, or an increase of nearly 33 per cent. in three years. Similarly passenger traffic increased 29 per cent. in the same period. This shows quite clearly the possibilities for increased traffic which will be developed when this improvement work is finally finished.



Profile of Southern Railway Second Track Improvement Work at Spottswood, Va.

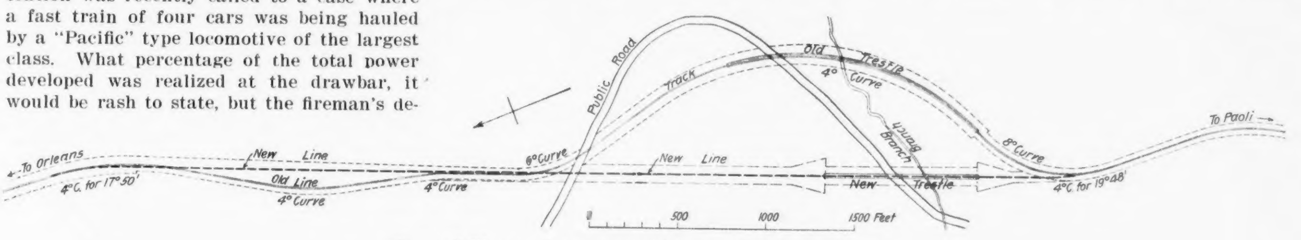
The section between Alexandria and Manassas, 26 miles, has been in operation for over a year. Between these points the most important work has been done; a large number of curves have been eliminated, and grades have been materially reduced. The second track runs parallel to the present main line on an even grade from Alexandria to Edsalls, seven miles. At this point it strikes an ascending grade of .5 per cent. for about half a mile, until it reaches Springfield. From here an entirely new line has been laid out, running to mile post 18. This revision has necessitated a number of cuts, including one 45 ft. deep. From Sideburn to mile post 20 the new line follows the present line very closely and runs on a grade of about 1 per cent. until it reaches Manassas. From Manassas to Orange the work has consisted of paralleling the present main line, except at Culpeper and Rapidan. The ruling grade southbound on this section is 1 per cent., while the ruling grade



Sixty-Foot Cut at Culpeper, Va.—Southern Railway.

and is practically doing the work of a six-coupled engine. The Pennsylvania has tried six-coupled engines in passenger service, but it is believed that, in some cases, a four-coupled type. Six-coupled locomotives are doing magnificent work on many roads, but it is believed that, in some cases, a four-coupled engine would be preferable and would result in economy. The writer's attention was recently called to a case where a fast train of four cars was being hauled by a "Pacific" type locomotive of the largest class. What percentage of the total power developed was realized at the drawbar, it would be rash to state, but the fireman's description of the engine as a "coal hog" was probably not far from the point.

PAUL T. WARNER.



Plan of Monon Improvements near Paoli, Indiana.

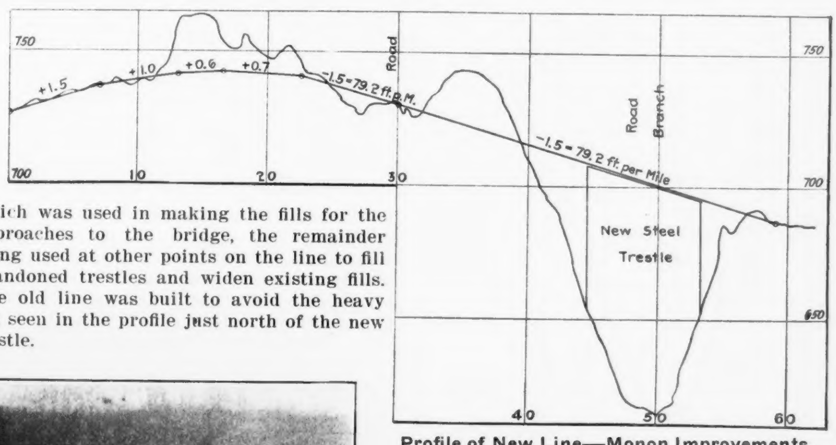
The Paoli Trestle on the Monon.

BY A. E. KEMMER.*

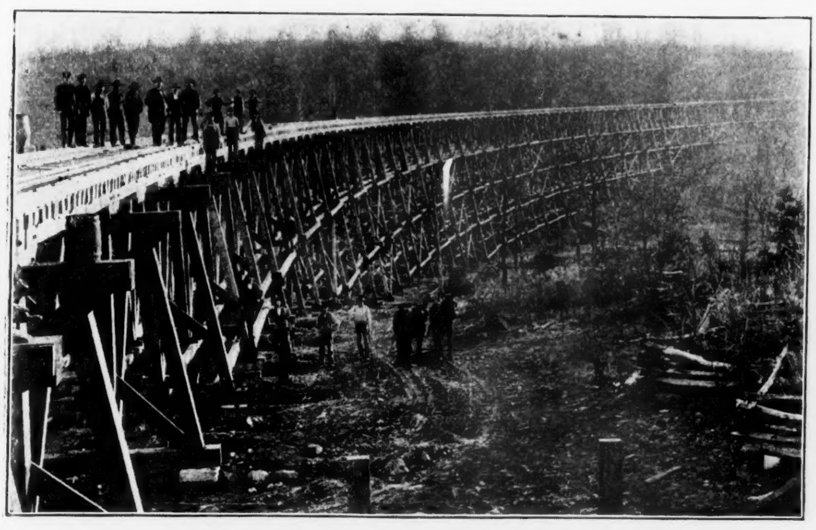
The Chicago, Indianapolis & Louisville has recently completed some heavy improvements extending over about a mile of track on its Orleans, West Baden & French Lick branch near Paoli, Ind. The work was begun in May, 1903, and was finished last June. The changes made, which are shown in the general plan of the improvement, included the elimination of 190 deg. 20 min. of curvature and 12 ft. of rise and fall and the track was shortened about 180 ft. A pine trestle 1,567 ft. long and 78 ft. high in the center was abandoned and a new steel trestle 870 ft. long and 87 ft. high in the center was built for the new line. About 65,000 cu. yds. of excavation were taken out, a portion of which was used in making the fills for the approaches to the bridge, the remainder being used at other points on the line to fill abandoned trestles and widen existing fills. The old line was built to avoid the heavy cut seen in the profile just north of the new trestle.

The new steel trestle, which spans a wide ravine and a small stream, was the most important feature of the work. The abandoned wooden trestle and the new structure are shown in the illustrations. About 4,300 cu. yds. of first class masonry are included in this work. It consists of two abutments and 36 small piers, four piers being used to support each tower of the trestle. Bedford

*Assistant Engineer C., I. & L. Ry.

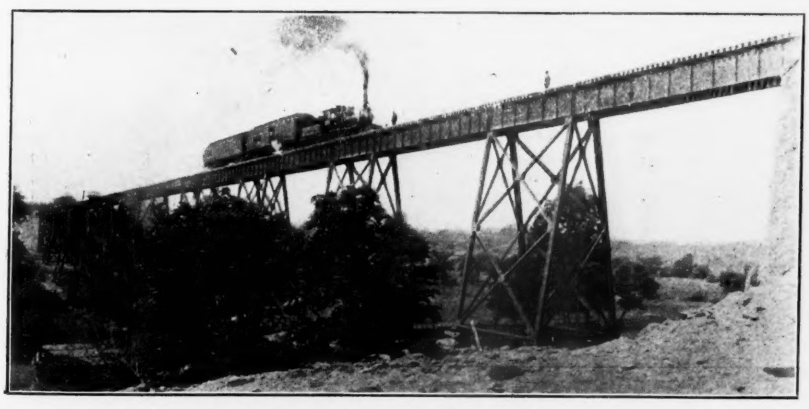


Profile of New Line—Monon Improvements.



Abandoned Wooden Trestle on a Curve.

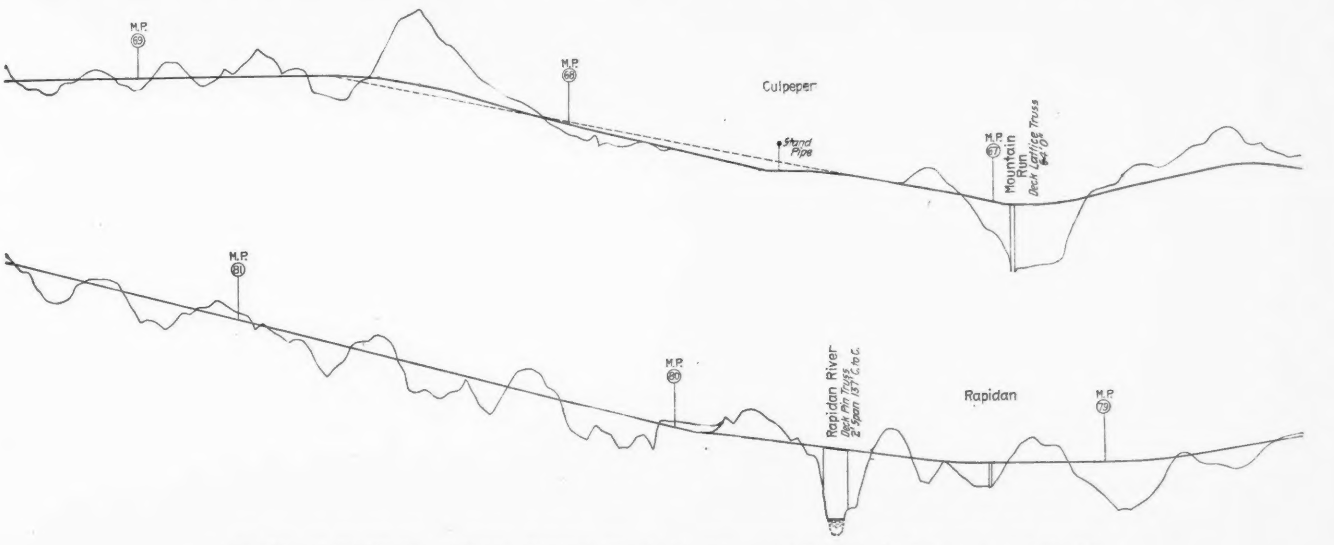
Erection View of Paoli Trestle.



New Steel Trestle Replacing Old Wooden Structure.

northbound is .8 per cent. There are 18 bridges on the section, the largest ones of which are located as follows: Broad run, a pin truss bridge, 113 ft. long, with two spans; Cedar run, a deck pin truss, 156 ft. long; Rappahannock river, a through pin truss, with three spans, measuring respectively 113 ft., 124 ft. ¾ in. and 152 ft. 4⅞ in. in length; Mountain run, a deck lattice truss bridge, 64 ft. long. At Cannon branch there is a 35-ft. concrete arch and at Kettle run a 55-ft. concrete arch has been built. All the other arches on the line average about 12 ft. The maximum cut on this section is 60 ft. and the maximum fill is also 60 ft. The line from Manassas to Culpeper, 34 miles, did not involve much heavy work, but from Culpeper to Orange a large amount of heavy work was made necessary by the rock formation which was encountered. At Culpeper no attempt was made to parallel the existing main track, as the present cut is of rock. In order to take this out without interrupting traffic, it would have been necessary to quarry the material, which would have been extremely expensive. An offset line was, therefore, adopted, using one track for northbound traffic and the other for southbound traffic. At Rapidan the old line was abandoned for a distance of about four miles owing to the fact that the present line is down grade at this point and on a curve approaching the bridge, making it very dangerous from an operating standpoint. To aid in avoiding this, concrete abutments were put in, raising the new line 10 ft. above the former line. The new bridge over the Rapidan river is of deck pin truss construction, with two spans, each measuring 137 ft. long. The heaviest cuts on this section are at Culpeper and Spottswood, the former necessitating the removal of about 120,000 cu. yds. of earth and the latter about 150,000 cu. yds. In both these cuts several strata of rock were encountered and it was necessary to do a large amount of blasting, as shown in the accompanying photograph. The entire line is now practically completed and will probably be thrown open for traffic in the fall. The general excavating work has been done by W. J. Oliver & Co., Knoxville, Tenn. The new line will enable the Southern to successfully carry the large amount of freight and passenger traffic which daily passes over this line for the South.

We are indebted to W. H. Wells, Engineer of Construction, for the drawings and photographs shown.



Profile of Southern Railway Second Track Improvement Work at Culpeper and Rapidan.

Pig Iron Feasts and Famines.*

Eight times within the last eighty years the industries of the United States have been subjected to the blighting influences of an iron famine. During these famines, all shapes of iron and steel have undergone an enormous advance in prices. These famines have not resulted from the falling off in the volume of production, but from the rapid increase in consumption, and from the impossibility of supplying the demand. It requires a year to a year and a half to build a furnace for producing iron. The average stock of iron carried in the United States for the last 20 years has been less than three weeks' production. Under these circumstances when the demand for iron has increased largely and quickly, say 100 per cent. within four or five months, it has left an unsatisfied demand—a void, which could not be filled, and in the ensuing struggle among the many consumers to get what little iron was produced over and above what was pledged by contract, these enormous advances have occurred. The late Hon. Abram S. Hewitt had for 40 years predicted these wonderful increases in consumption on the cumulative increase in the per capita consumption, together with the rate of increase in population. In 1855, for instance, the population was about 27,000,000 and we consumed about 100 lbs. per capita; in 1890 it was about 62,000,000 and we consumed about 300 lbs., and in 1902 it was about 81,000,000 and we consumed about 500 lbs. per capita. All of Mr. Hewitt's predictions have been more than verified. In his address to the American Institute of Mining Engineers, in 1890, when the production was about 9,000,000 tons, he said that this country would require at least 14,800,000 gross tons of iron per annum in 1900, and made it perfectly clear that there was no more doubt that this result would be realized than there was that the growth of the country would continue. With such evidences of what was to be expected, it is hard to understand why, in 1895-96-97, producers did not run their furnaces to the utmost capacity, sell as little iron as they could, and pile up as much reserve as possible on which to reap the benefit of the high prices so certain to come. What they actually did was exactly the reverse: In nearly every iron producing district, meetings were called for the purpose of bringing about an agreement to restrict production, with less than 1,000,000 tons of stock on hand, and when the country was on the eve of a return of prosperity which required 37,000,000 tons above the ordinary annual product. The furnaces might have piled up a stock equal to several months' production, and still have realized an enormous advance. In Sctoland there was an advance of 75 per cent. in 1889, with a reserve stock in warrant yards equal to a year's production, but it would have prevented the advance of 200 to 300 per cent. which actually occurred, and from which we are now suffering the logical results.

In attempting to explain why a large stock was not accumulated in the United States, in the face of seven such experiences and the oft-repeated warnings that the increase was so sure to recur as the country was sure to continue its growth, I find nothing which seems to hit the nail so squarely on the head as the view of the Scotch ironmaster, which in substance is that Americans are too busy to take long views of business, and as evidence of this he cites the fact that our newspapers (which proverbially give the public what it desires) rarely ever quotes prices and conditions back for more than a month or a year. In discussing the Scotch pig iron warrant system, a Glasgow gentleman said, in effect, that the warrant system has been to us a great educator. Through it we have learned to take broad views of business. We look upon prices and stocks of iron not in the light of a month or a year, but in the light of 10 or 50 years. We argue that what has occurred in the past will be repeated in the future, if the same causes exist in the future. We have learned that every few years there is a sudden and great increase in the demand for iron, with a corresponding increase in its price, and we shape all our business calculations to take advantage of these periodic conditions, with little regard to what the conditions are for the current year. The delusions which result from looking at the iron business in the light of a month or a year are many. For instance, each time that pig iron has experienced several years of low prices in the United States, there has come a general belief that the price of iron would never again reach abnormally high figures. If one attempted to combat this belief, his arguments were swept aside by the declaration that "conditions are different now from what they ever were before," but the high prices

*Extract from a paper read by Geo. H. Hull at the Atlantic City Convention of the American Society for Testing Materials, June, 1904.